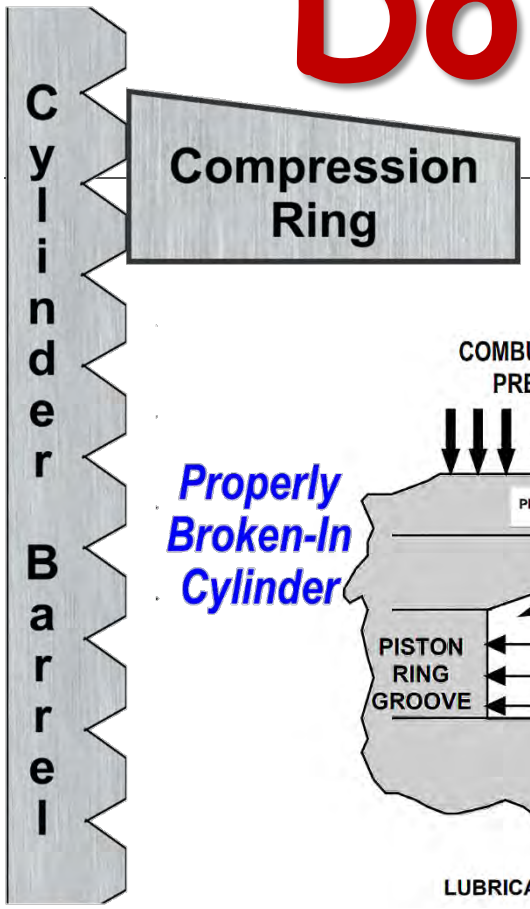
Cylinder Break-In:

Do It Right!



Your presenter…

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National Aviation Maintenance Technician of the Year (2008)

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Breaking-in new cylinders

- One or two replaced cylinders
- All cylinders ("top overhaul")
- New/rebuilt/overhauled engine

Lots written on this subject

- Engine manufacturers
  - Continental M89-7R1
  - Lycoming SI 1427B
- Cylinder manufacturers (SAP, ECi)
- Overhaul shops (RAM, Penn Yan, Victor)
- Shell Oil Company

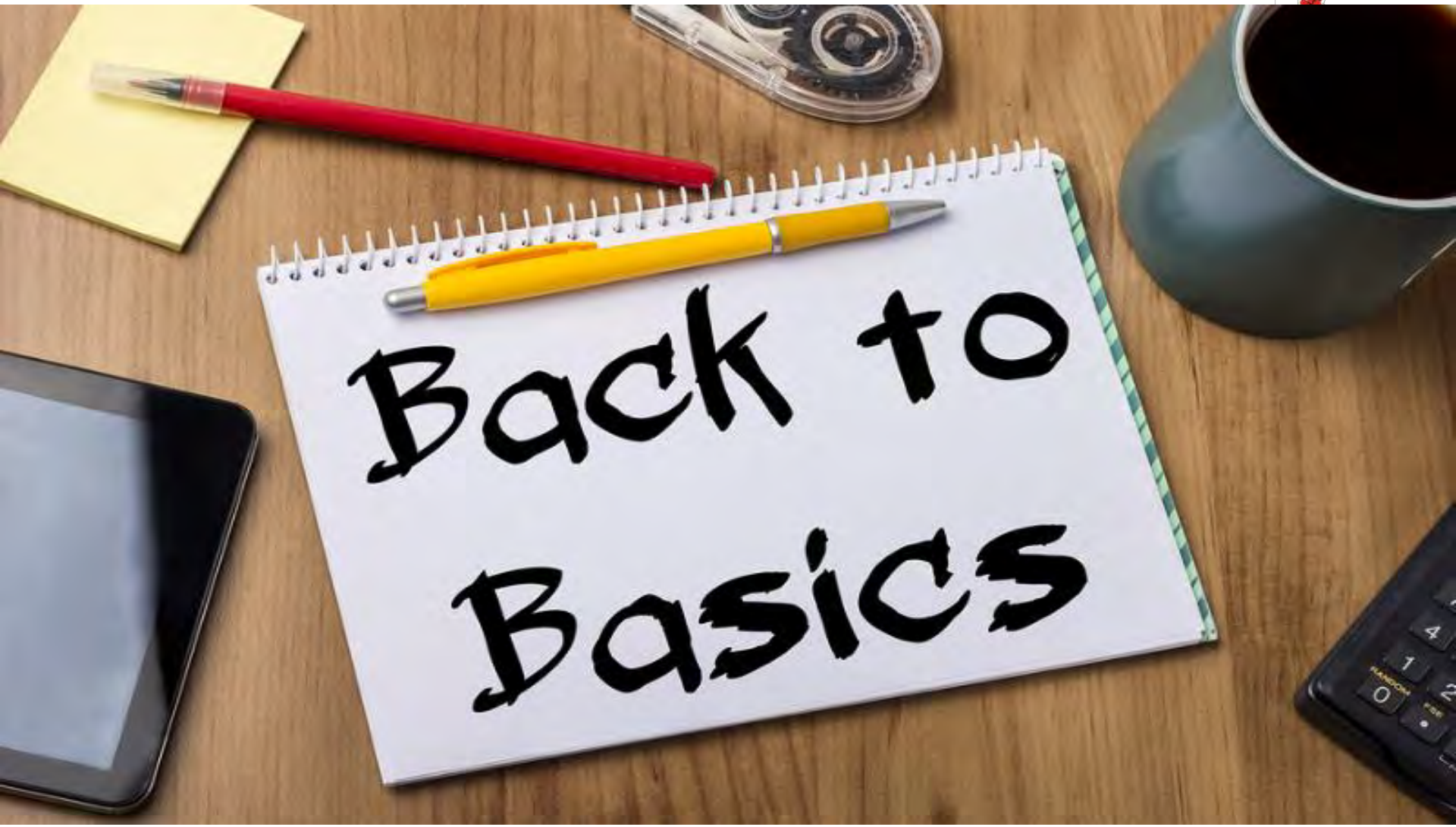
Lots

- Eng
  - Co
  - Lyc
- Cylin ECi)
- Over Victor)
- Shell Company

Pretty confusing…

Some common threads

Lots of disagreement (about power settings, type of oil and when to change it, and how long break-in should take)



Aluminum alloy cylinder head

Hardened steel barrel

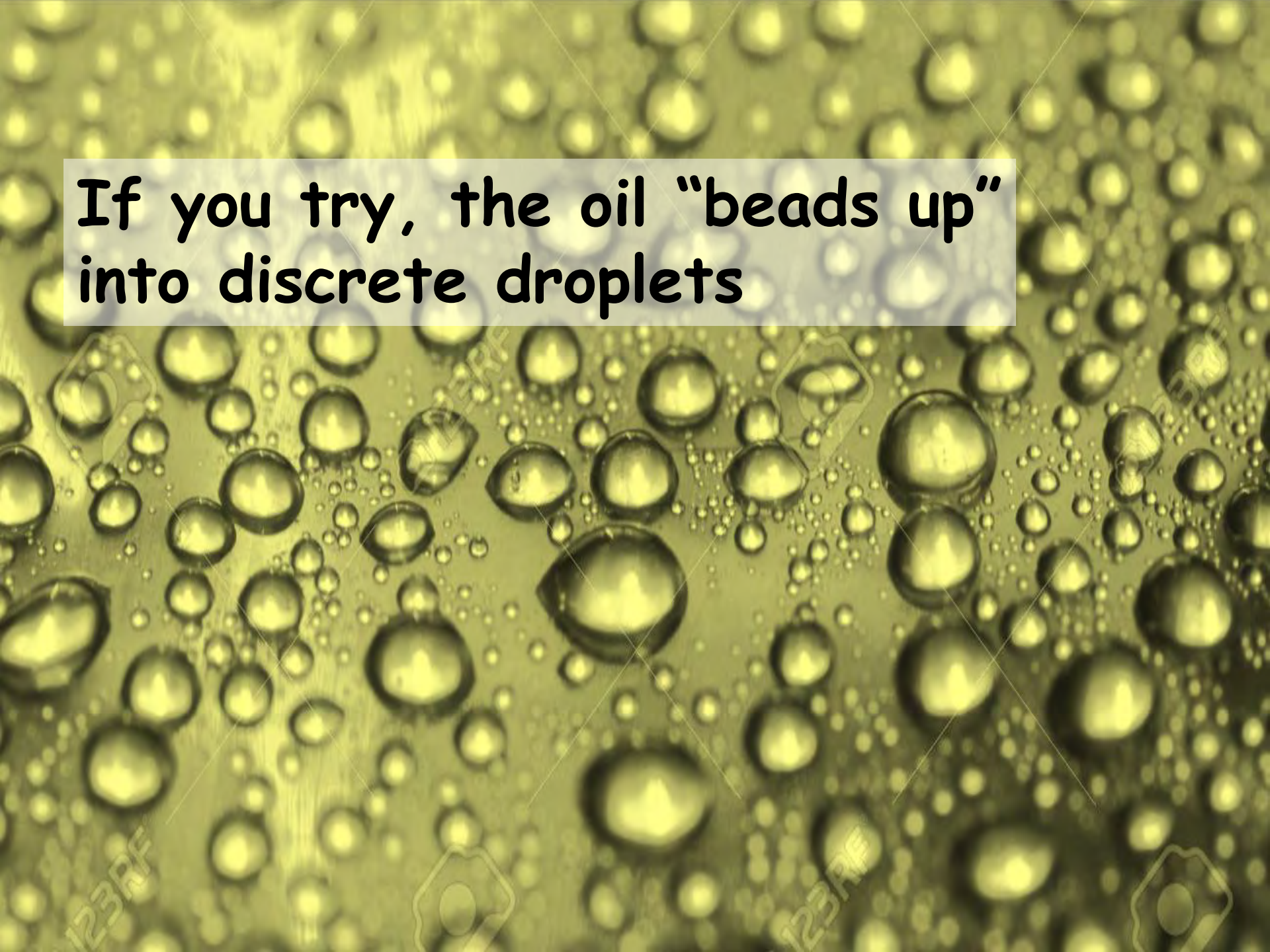
Aluminum alloy piston

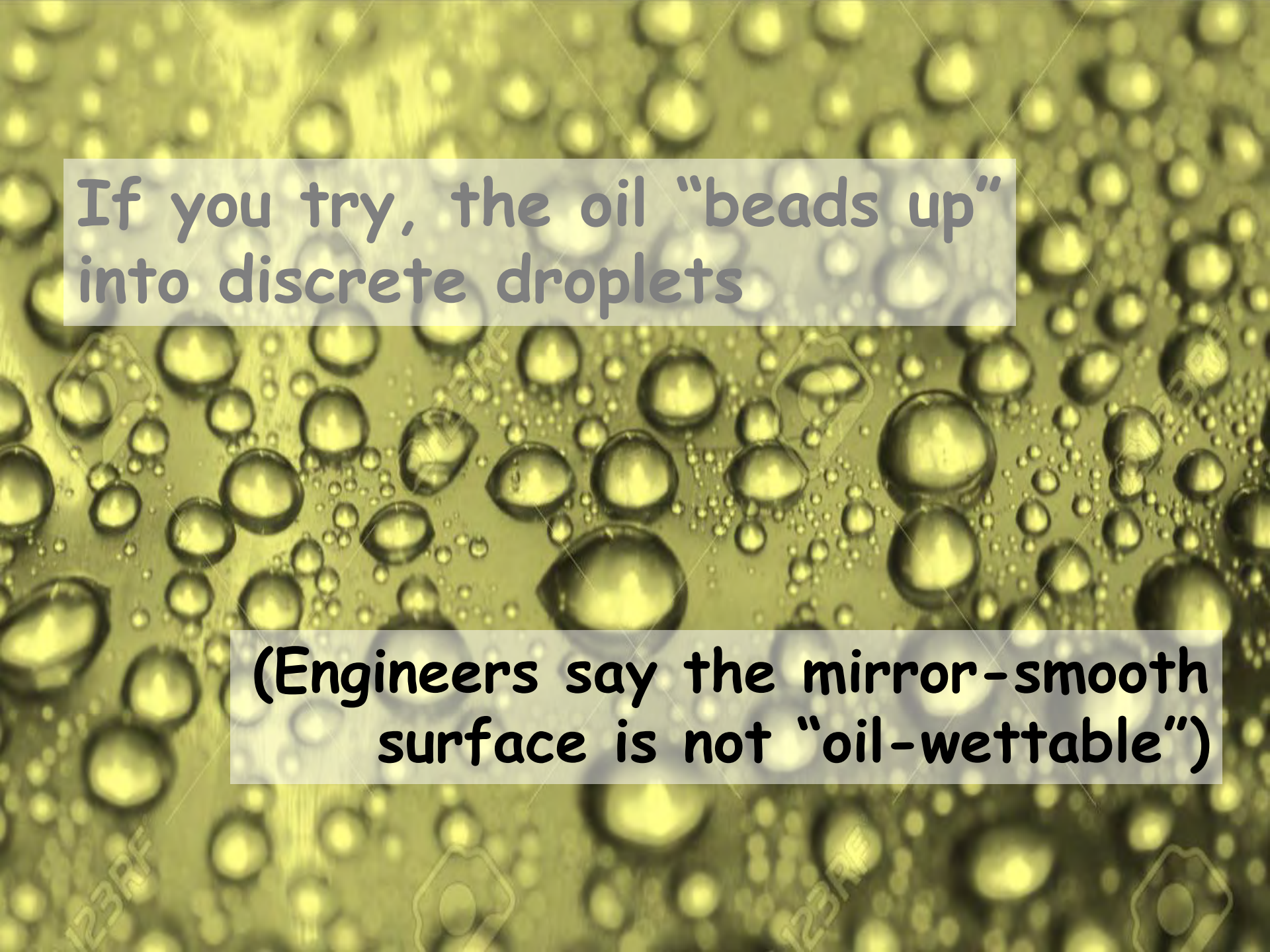
As the piston reciprocates inside the barrel, the compression rings hydroplane on a film of oil, minimizing metal-to-metal contact

When the cylinder barrel is initially machined at the factory, it comes out of the CNC machine with a mirror-smooth interior finish

When the cylinder barrel is initially machined at the factory, it comes out of the CNC machine with a mirror-smooth interior finish

This won't do: It's impossible to coat a mirror-smooth steel surface with a thin film of oil…

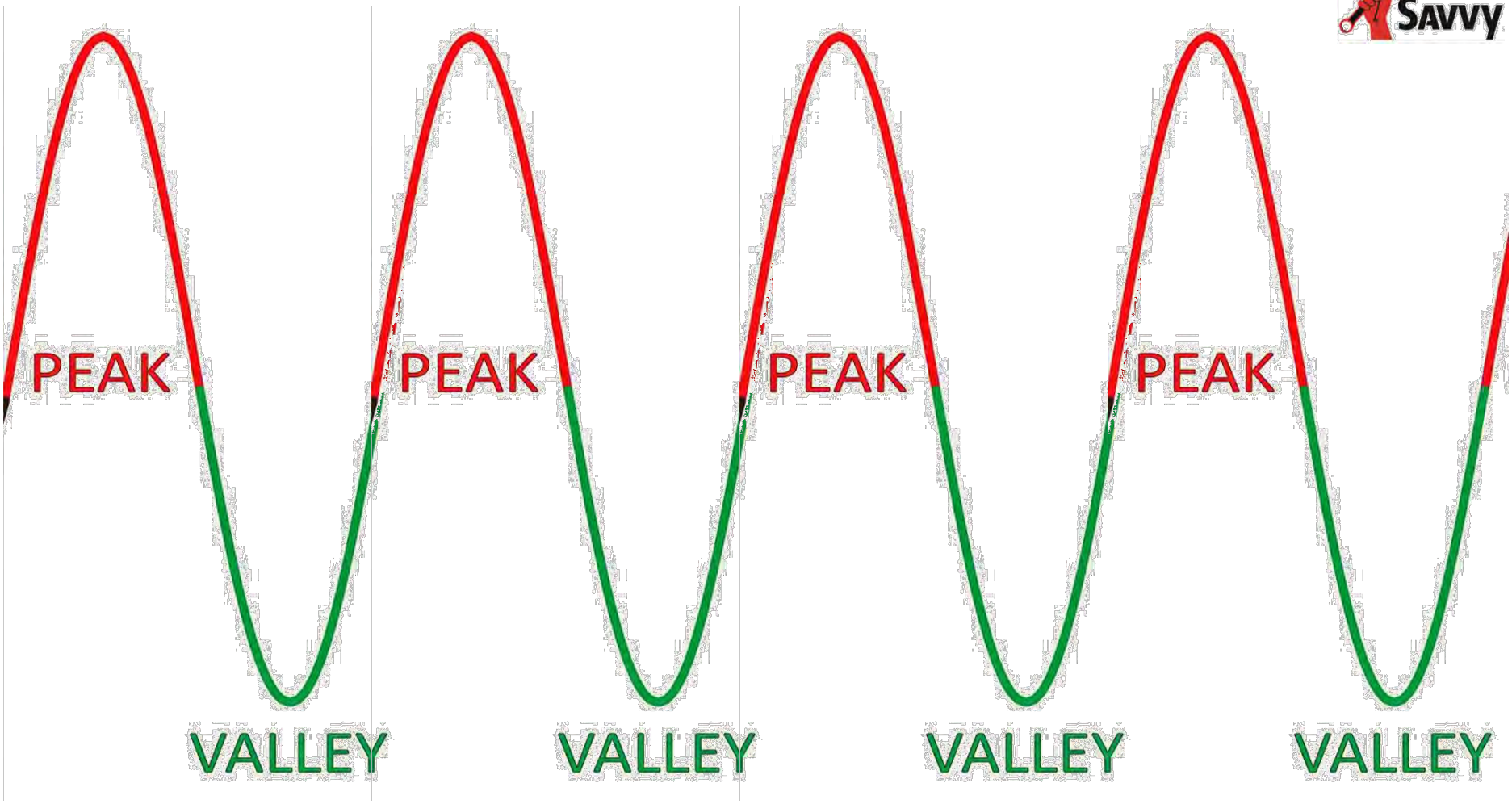

If you try, the oil "beads up" into discrete droplets

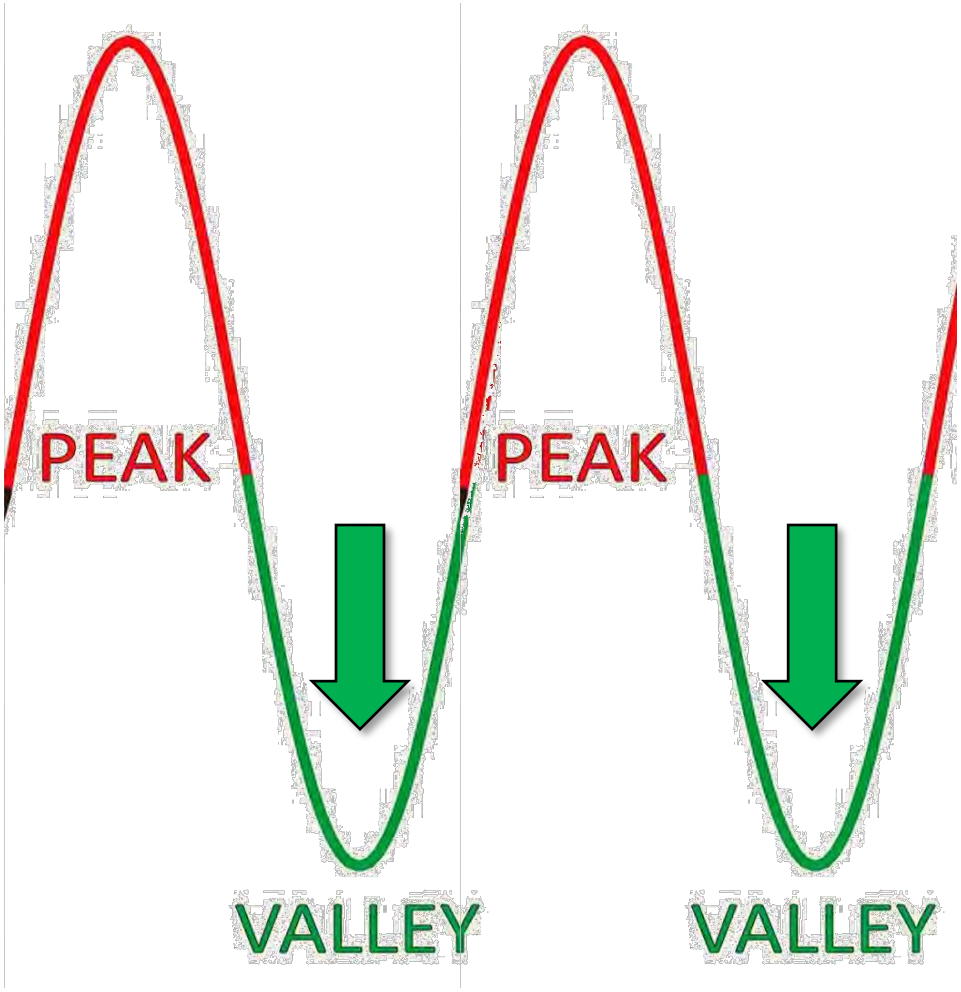

If you try, the oil "beads up" into discrete droplets
(Engineers say the mirror-smooth surface is not "oil-wettable")

To make the barrel oil-wettable, the surface must be roughened

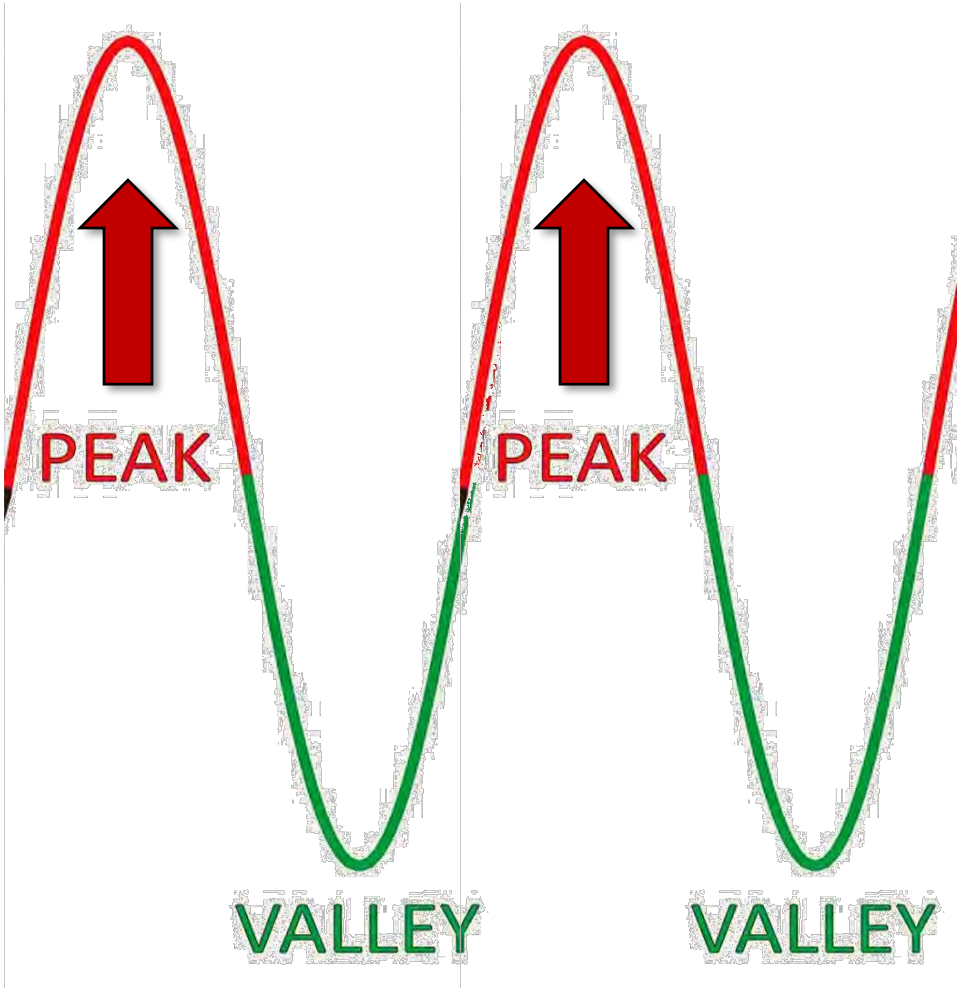
This is accomplished using a honing tool with very hard 220-grit stones to create a crosshatch (pattern of tiny scratches)

This is sometimes called a "microfinish" because the honed scratches are typically only about 30 microinches (0.000030") deep





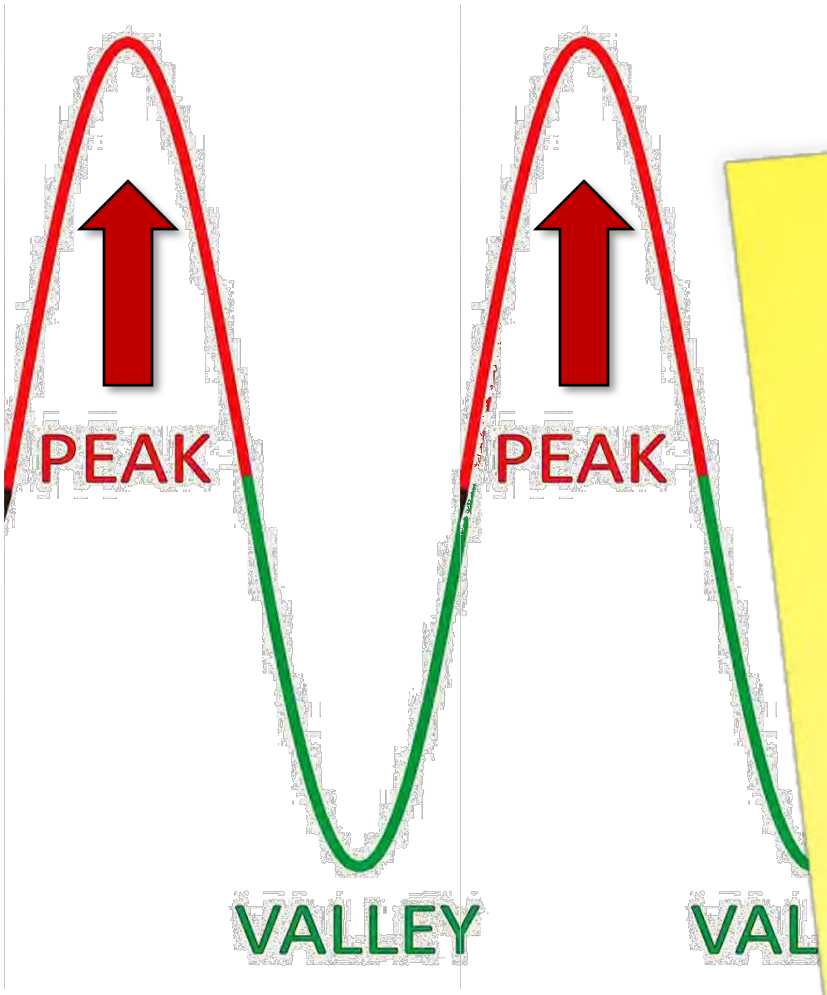
The valleys (fissures) cause the surface to be oil-wettable by providing tiny "footholds" for the oil film to adhere to



The peaks (ridges) are problematic

They increase friction and cause the barrels to run hot

The peaks



The purpose of break-in is to smooth off those pesky peaks, while leaving the valleys intact

It would be nice if this were done at the factory

To some extent, it is…

- Some cylinders have multi-step honing
- All factory new/rebuilt engines and some overhauls are run in a test cell
- Field-replaced cylinders get no run-in

It would be nice if this were [illegible] factory

To s[illegible]...

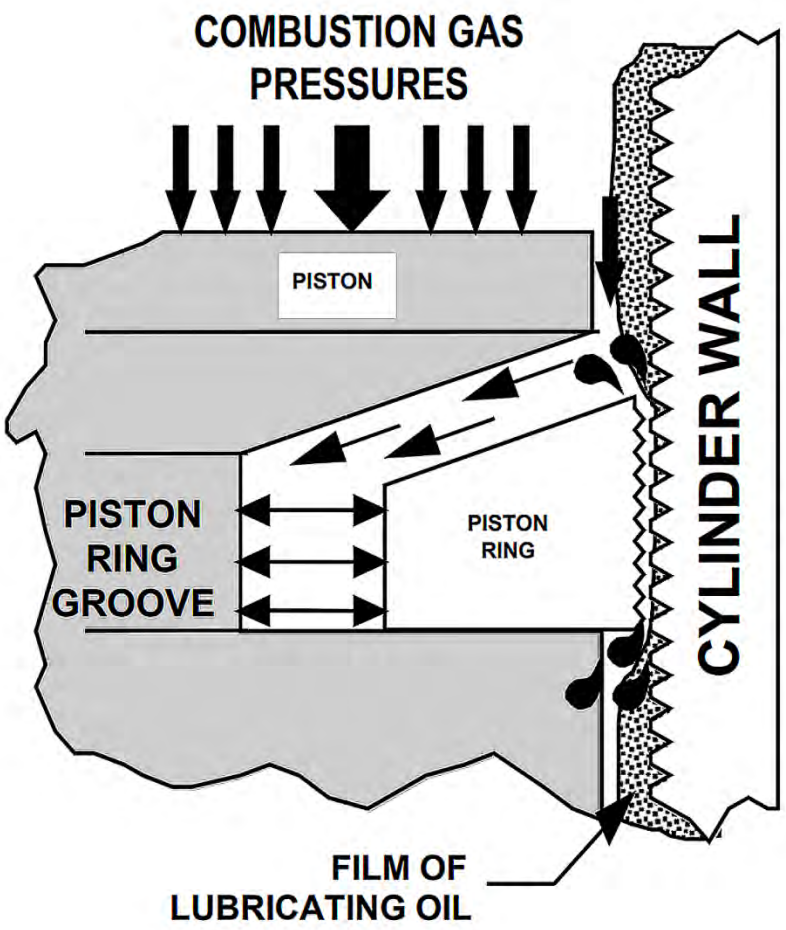
- Som[illegible]step honing
- All f[illegible]nes and some[illegible]test cell
- Field-replaced cylinders get no run-in

In all cases, the final break-in is always left to the pilot who flies the first post-install flights

Break-In Fundamentals

During normal engine operation, the goal is to lubricate the cylinder barrel with an oil film sufficiently strong and thick to prevent most metal-to-metal contact between the rings and the barrel

During break-in the goal is just the opposite: to breach the oil film and cause sufficient metal-to-metal contact to grind off the sharp peaks of the crosshatch while leaving the valleys intact



To do this, we need to run the engine really hard for the first hour or two, creating enough gas pressure to breach the oil film and force the rings against the cylinder wall

It's also important that the oil film isn't too strong to be breached, so the choice of break-in oil is important

Traditionally, break-in has been done using "straight mineral oil" that contains no synthetics, ashless dispersants, anti-wear/anti-scuff additives, or viscosity index improvers

It's also important that the oil film isn't too ed, ak-in nts, additives, or viscosity index improvers

In recent years, some manufacturers and overhaul shops have been moving away from recommending such primitive oil

Synthetics have higher film strength than petroleum-based oils, which is obviously bad for break-in

Anti-wear/anti-scuff additives should also be avoided, since scuffing is what we're trying to achieve during break-in

However, I've seen no persuasive evidence that ordinary ashless dispersant (AD) oil is any less effective for break-in, and it keeps the engine cleaner

I prefer to break-in using AD oil

There is some controversy over whether it's better to use single-weight oil or multigrade oil for break-in

While I've used mostly W100 for break-in, there's a good argument for using an all-petroleum multigrade like Phillips X/C 20W-50

Avoid during break-in…

Synthetics

Anti-wear/scuff additives (or oils containing them)


Run the engine hard during break-in…
…but how hard?

Ideally, we'd like to run the engine as hard as possible—close to 100% power would be optimum—for an hour or two

But we must take care not to overheat and damage the new cylinders

New cylinders will run hotter than normal until the break-in process is complete

By far the best way to run the engine hard—but not too hard—is to use an engine monitor that displays the CHT of every cylinder

Here's what I recommend:

Run as close to maximum power as possible without allowing any CHT to exceed 420°F for Continental jugs or 440°F for Lycoming jugs

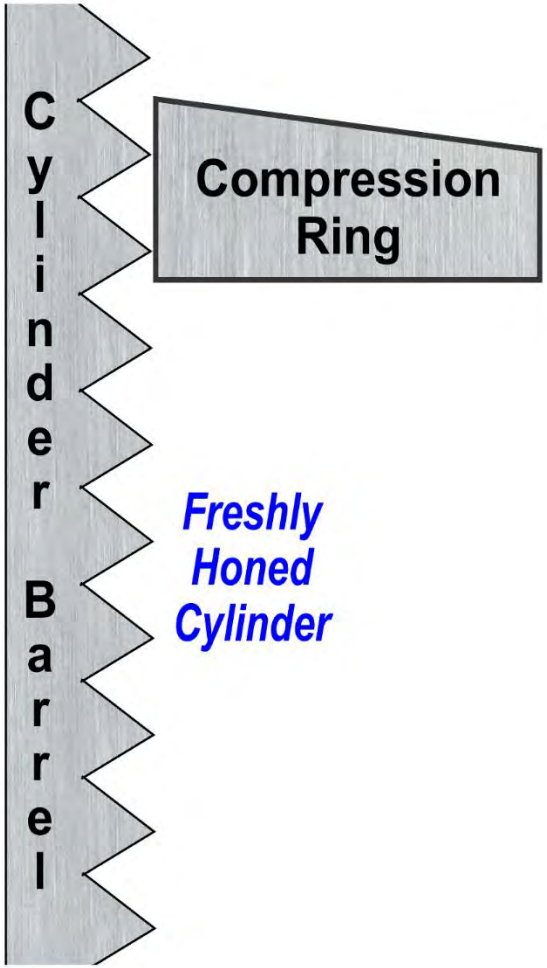
Do this for an hour or two until CHTs come down noticeably, indicating break-in is successful

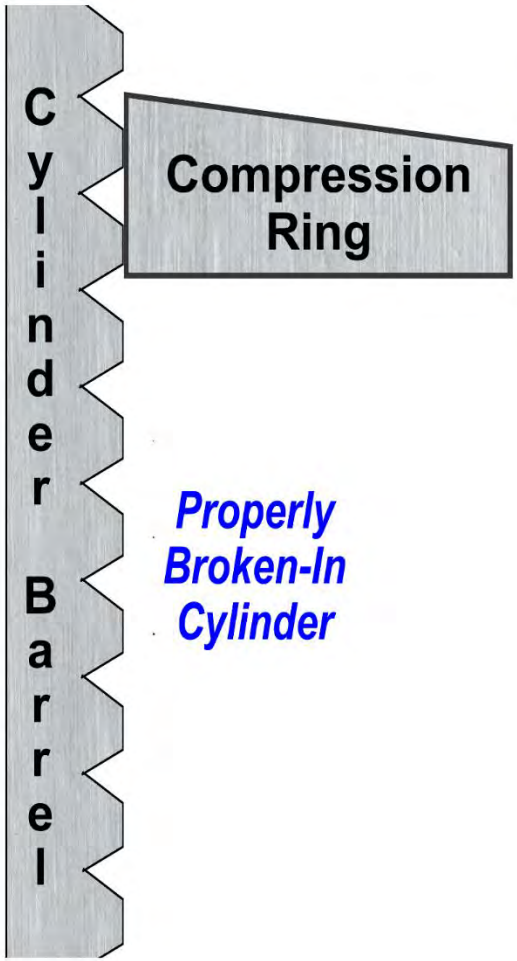
It's very important to run the engine hard right from the outset

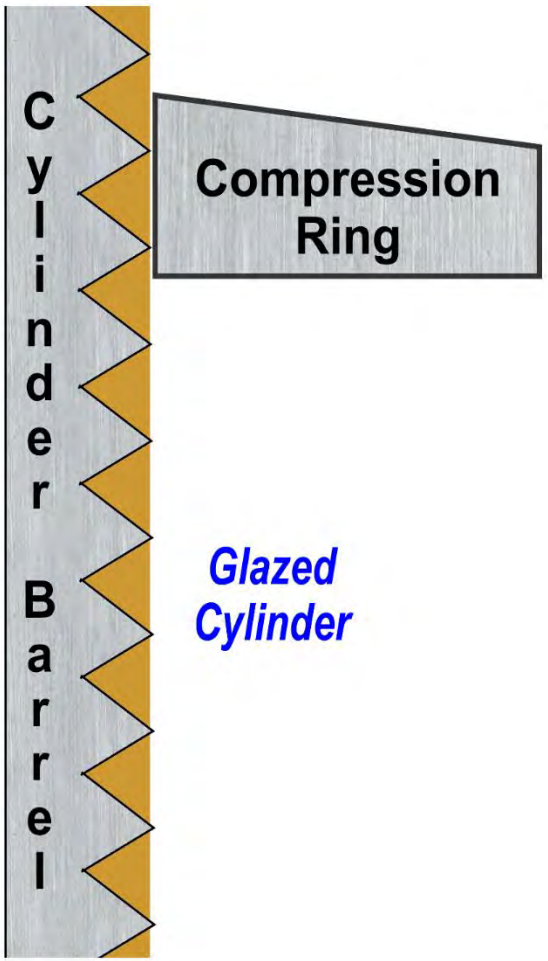
Keep ground running to a minimum, avoid a protracted runup, and don't cycle the prop more than once

Here's why:

Running a freshly honed cylinder at low power can cause a condition known as "glazing" in which a tough residue of carbonized oil builds up on the cylinder walls and stops the break-in process dead in its tracks







Rules for break-in

- ✓ **Use the right oil**—no synthetics or anti-scuff
- ✓ **Run the engine hard**—as close to 100% power as possible without abusive CHT
- ✓ **Minimize ground and low-power ops**—at least for the first few hours

How long should it take?

- **Steel cylinders** should break-in within about 5 hours if you do everything right

- **Nickel-carbide cylinders** will break-in very quickly and have low oil consumption
- **Channel chrome cylinders** take longer to break-in—sometimes 25+ hours—and have higher oil consumption

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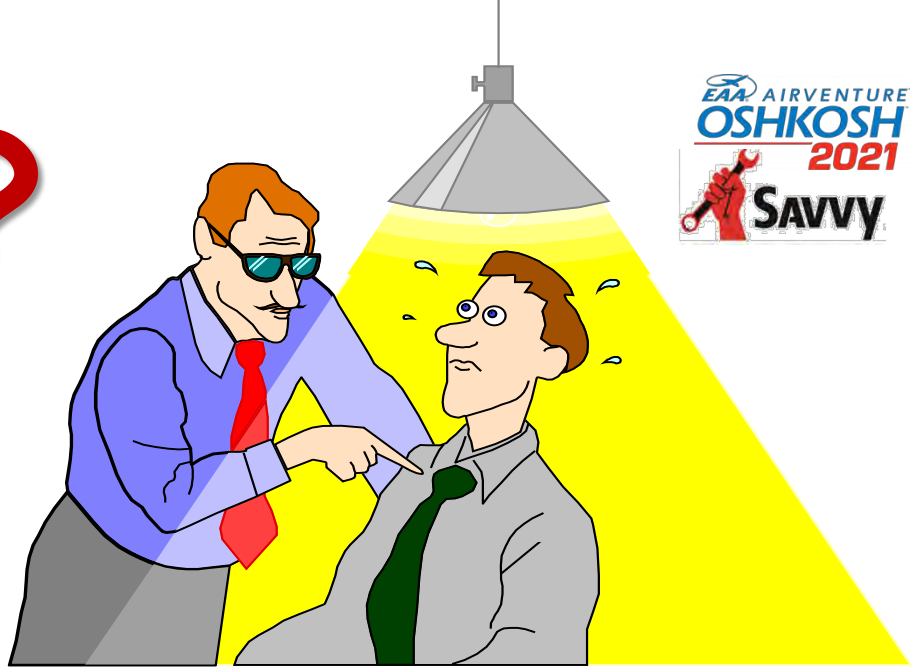

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